# Rock Chips

Spring 2011

Alberta Geological Survey

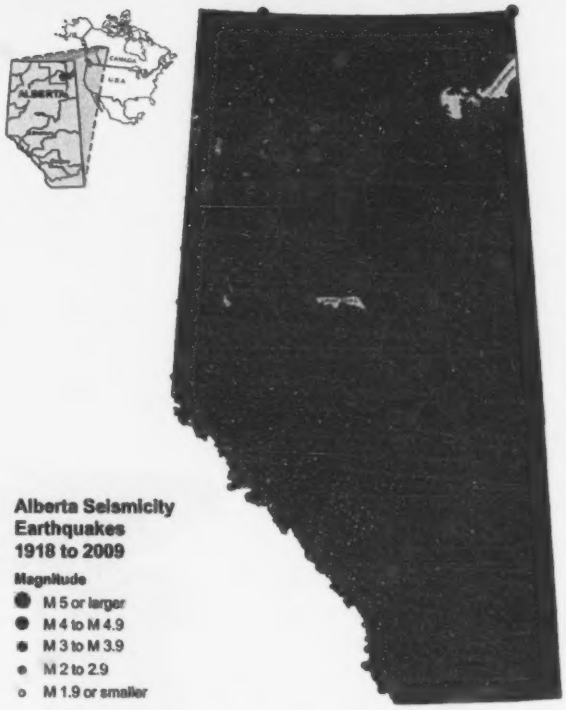
## Induced Seismicity Project

One of the mandates of the Energy Resources Conservation Board (ERCB) is to investigate physical geological hazards in Alberta. The Alberta Geological Survey (AGS), part of the Geology, Environmental Science and Economics Branch of the ERCB, has initiated the Induced Seismicity Project to document both natural and induced (or triggered) earthquakes. Our goal is to understand the distribution and nature of earthquakes within Alberta through

- real-time monitoring of seismic stations;
- establishing a database of recorded earthquakes; and
- collaborating with Alberta research institutions to facilitate a deeper understanding of the relationship between anthropogenic activities and micro-earthquakes.

Most of the earthquakes that occur in Alberta are very small. These are termed micro-earthquakes, which are less than 3 local magnitude (ML). Although these earthquakes are typically not felt, the information contained within the events is important to our understanding of the processes that may have a potential to trigger earthquakes.

In 2009 and 2010, AGS provided in-kind field support to the University of Calgary to facilitate its installation of eight Alberta Telemetered Seismograph Network (ATSN) stations (blue squares on station map, next page). In the summer of 2010, AGS provided similar support to the University of Alberta to maintain its system of non-telemetered Canadian Rockies and Alberta Network (CRANE) seismic stations (green triangles on station map). These stations complement




existing permanent Canadian National Seismograph Network (CNSN) stations installed and maintained by the Geological Survey of Canada (red stars on station map).

In the spring of 2010, AGS purchased state-of-the-art software, Boulder Real Time Technologies' Antelope, to acquire real-time seismic data. Government projects worldwide use Antelope, such as the American USArray, a nation-wide, seismic network of more than 400 permanent and portable seismographs providing data for studies of the continent and deep Earth structure; the Australian Tsunami Warning Centre, whose mandate is to detect and monitor potentially tsunamigenic earthquakes; the Pacific Geoscience Centre, the western branch of Earthquakes Canada,

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responsible for monitoring earthquake activity across Western Canada; and many U.S. universities. We installed the Antelope software at AGS in June 2010, and have been collecting and archiving data from the ATSN stations and several of the CNSN stations ever since.

Through continuing modification of the Antelope software parameters, AGS began detecting and locating earthquakes in January 2011. Today, whether they are quarry blasts, natural events or induced events, AGS' automated Antelope system monitors for, detects and locates seismic events within minutes of their occurrence. Our staff reviews and archives these data in a relational database.

In addition to the real-time data, AGS has been working with the University of Alberta to analyze several years' worth of data collected from the CRANE stations to identify earthquakes not recorded by the telemetered stations and to refine the locations of recorded events. These data will be used to generate localized seismic velocity models using inversion techniques for the different regions of Alberta. The velocity models will improve the precision and accuracy of locations, particularly for micro-earthquakes that are recorded on fewer stations.

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Past and present issues of *Rock Chips* may be viewed on the AGS website at www.ags.gov.ab.ca.

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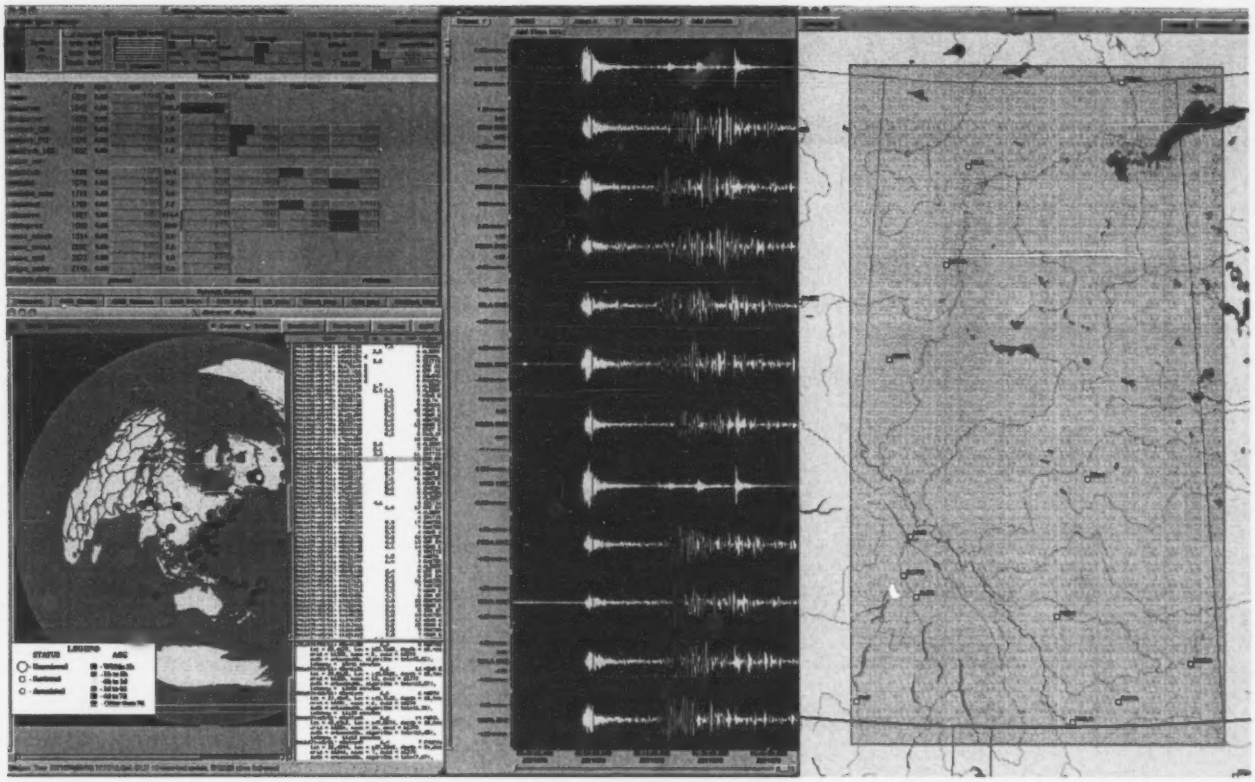
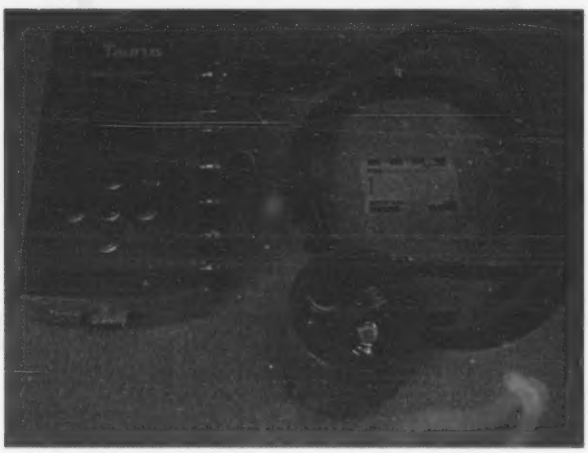
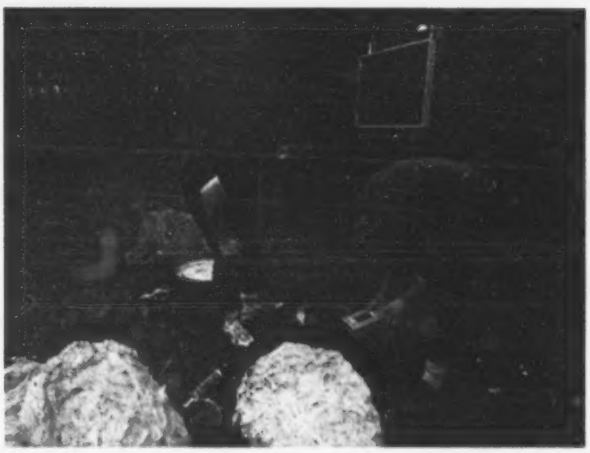


Screenshot of Antelope system featuring the real-time monitor (upper left) depicting system information, event map (lower left), station grid (right) and a waveform display of the March 11, 2011 magnitude 9.0 Japan earthquake offshore Honshu, Japan, picked up by stations in and around Alberta.,



A Taurus seismograph (datalogger on the left) connects to a Nanometrics compact Trillium seismic monitor (right) This equipment is used at a seismic station to detect ground disturbances.



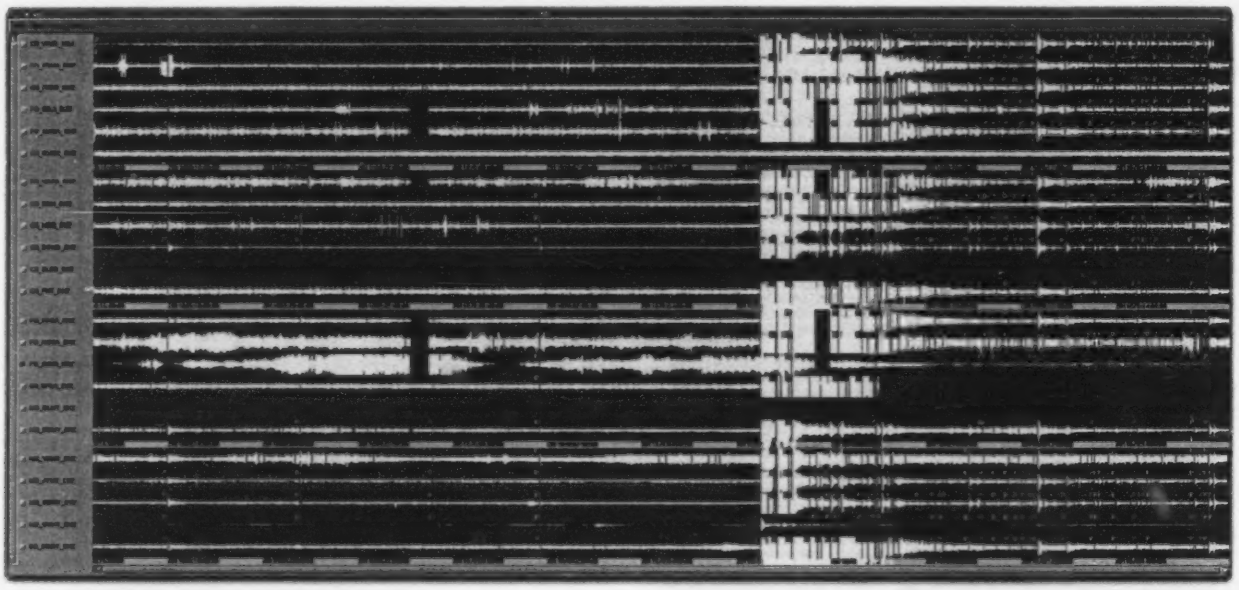
Two University of Alberta graduate students, Ryan Schultz (right) and Luyi Shen (left), inspecting an installed CRANE seismic station near Peers, Alberta.

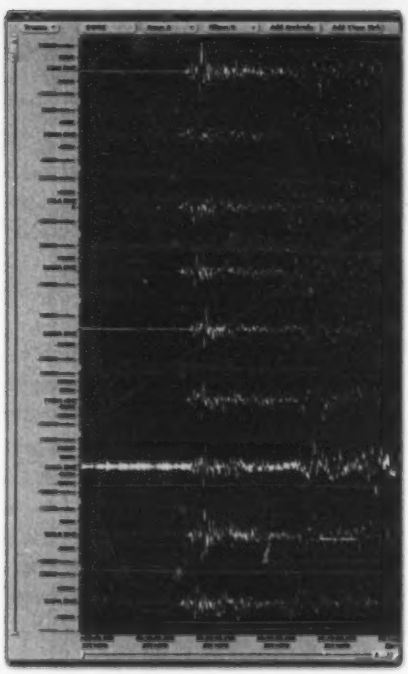
Our Induced Seismicity project members are monitoring and locating earthquakes, determining earthquake source parameters and collaborating with university students studying seismology. Alberta universities.can participate in summer programs with AGS, in which the students will have an opportunity to use world-class software, access real-time and historical data, and work with experienced scientists in this exciting field. Several publications are underway and will be released soon. Alberta Geological Survey will provide updates on progress and details of the program through its website and Rock Chips. ❖

# Alberta Seismic Stations Pick Up Japan Earthquake

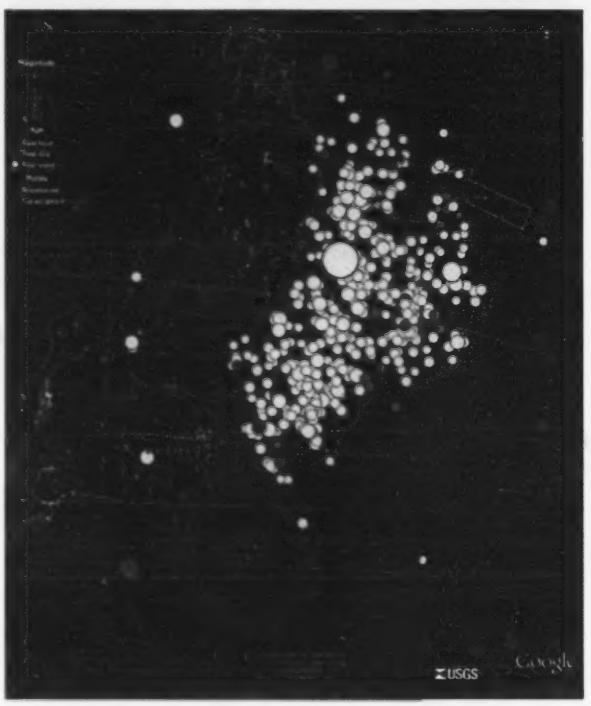
An earthquake measuring 9.0 occurred offshore (latitude 38.322, longitude 142.369) near the east coast of Honshu, Japan, on Friday, March 11, 2011 at 2:46 p.m. Japan time (Thursday, March 10, at 10:46 p.m. Alberta time). Japan experienced numerous, large foreshocks the previous two days. This earthquake was so strong that it was picked up by seismic stations worldwide, including those in Alberta.

The below image shows the waveforms from stations in and around Alberta. The middle of the image show the event occurring.





The image on the left shows a snapshot of the response of Alberta stations to the event. The red flags mark the arrival of seismic waves detected by seven stations of the Alberta Telemetered Seismograph Network and two stations of the Canadian National Seismograph Network. The image on the right shows earthquake locations in Japan.



# Central Geological Survey of Taiwan Visits the AGS Turtle Mountain Monitoring Project Team

Between October 18 and 25, 2010, Mr. Hsi-Hung from the Central Geological Survey of Taiwan visited the Alberta Geological Survey (AGS). His visit started with a three-day field trip to Turtle Mountain in south-western Alberta to view the monitoring network, a near–real-time system installed on the South Peak of Turtle Mountain to provide early warning in the event of a rock avalanche. There, the discussion focused on the three main components of the monitoring system:

- data recording
- data transmission, and
- data networking.

Hsi-Hung from the Central Geological Survey of Taiwan standing outside the Frank Slide Interpretive Centre with Turtle Mountain in the background.

The trip included a detailed review of the equipment that makes up each component and the challenges of operating such equipment in the harsh environmental conditions found on the mountain. The field trip concluded with a comprehensive overview of the global positioning system (GPS) monitoring network.

At the AGS office, the visit focused on the Geohazards Program with an emphasis on remote-sensing techniques used by AGS to detect and characterize landslide hazards. In addition, Mr. Hsi-Hung spent three days studying the emergency response protocol developed for Turtle Mountain, as well as the information to consider when responding to a rock avalanche. During these days, AGS staff explained the four-level alert system created to rank the probability of a rock avalanche and how specific roles and responsibilities have to be developed for each alert level.

Francisco Moreno of the Alberta Geological Survey explains the function of the GPS unit installed at the top of Turtle Mountain. The town of Frank is visible in the distance on the right. (Image taken from a webcam installed on the South Peak of Turtle Mountain. For live images visit http://www.ags.gov.ab.ca/geohazards/turtle_mountain/turtlecam/turtle_webcam.html).

Mr. Hsi-Hung continued his tour with stops at the City of Edmonton, Alberta Transportation and the University of Alberta. He then concluded his visit to Canada with a two-week stopover at the University of British Columbia. There, he received an overview of landslide run-out mechanisms and current developments in computer programming to model the maximum extent of rock avalanches.

This is not the first time a representative from an international research organization has come to learn from the experiences gained from the Turtle Mountain monitoring project and the technologies being used on site. Since 2006, we have hosted delegates and researchers from Norway, India, China and Switzerland who have wanted to learn more about advanced monitoring techniques and early warning protocols.

The Turtle Mountain Field Laboratory offers researchers an example of how a slow-moving rockslide can be monitored and how to conduct research in such a situation. Alberta Geological Survey staff members benefit greatly from these chances to discuss their work with similar organizations and to learn from the examples of others. ❖

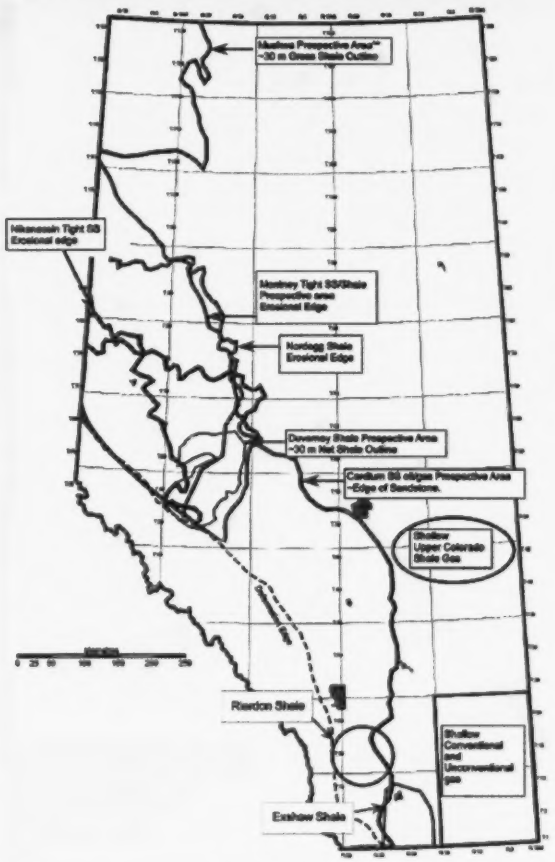
# What is Shale Gas?

Natural gas is found in many of the geological formations occurring in the subsurface of Alberta. Most produced gas is from distinct carbonate, sandstone- and siltstone-dominant bodies with discrete boundaries that trap large accumulations of gas, forming gas pools. The gas occurs in spaces between the sand grains or in void spaces within the rock matrix (the rock's pore spaces, or porosity). The buoyant nature of gas allows it to migrate into the porous sandstone bodies via interconnected pores (permeability) in the rock. Gas is often trapped or retained in these pools by the presence of an overlying, relatively impermeable/low porosity layer of rock (cap rock or seal).

The impermeable cap rock is often shale, a rock mainly comprising clay minerals with a predominately very fine (< 4 micrometres) grain size. Both of these features contribute to the low permeability and low porosity of shale. Over millions of years, sediment may be buried and subjected to heat and pressure. This compacts the sediment into a rock that has the potential to be a tight cap rock for hydrocarbon trapping. In some shale, there is a small amount of organic matter present, the remains of plant and animal matter incorporated in sediments at the time of deposition. Organic matter also undergoes chemical and physical changes during burial, generating oil and gas.

Generated gas may migrate slowly from the organic matter, through the shale, and travel along more permeable and porous beds (e.g., siltstone and sandstone layers) until it is trapped, forming a gas pool. If the shale is impermeable, the shale itself may retain much of the gas as free gas in the shale matrix or in interbeds of coarser grain size. Some of the generated gas is adsorbed onto organic matter. The occurrence of trapped and adsorbed gas in an organic-rich shale makes the shale both a potential seal or cap rock for hydrocarbon pools, and a combination source and reservoir rock. Organic-rich shale that contains both free and adsorbed gas is referred to as a gas shale.

The gas contained in a shale reservoir is called shale gas. Shale reservoirs tend to occur over a broad geographic area rather than in discrete pools. To produce gas, the permeability (interconnection of pore spaces) in the rock needs to be increased – this is achieved by artificial fracturing (fracing) of the rock. The right combination of organic matter content, level of maturation, structure/fractures and rock properties favourable for fracing will determine a shale's gas production potential.




Map of prospective areas for exploration of unconventional oil and gas.

No less than 15 formations have the potential for shale gas, which may represent a valuable resource for the province. Various estimates for the total amount of shale gas in Alberta vary widely, from 80 to >10 000 trillion cubic feet. Although this is a wide range, and the actual amount of gas that is economically recoverable at this time is unknown, it points out the great potential size of the resource, which can contribute to economic benefits and energy security for Alberta.

Recognizing the importance of shale gas, the ERCB's Energy Resource Appraisal Group, in collaboration with Alberta Energy and Alberta Geological Survey, is conducting a systematic evaluation of shale formations. The study will help define the distribution of shale gas resources in areas where development is most likely to occur. Results of the study will be used in economic forecasting, development planning and regulatory process planning. ❖

## Recently Released Publications

http://www.ags.gov.ab.ca/publications/

### Digital Datasets

**DIG 2010-0022** Top of the Belly River Group in the Alberta Plains: Subsurface Stratigraphic Picks and Modelled Surface (tabular data, tab delimited format)

**DIG 2010-0023** Bedrock Topography of the Edmonton-Calgary Corridor, Alberta (GIS data, ASCII grid format)

**DIG 2010-0038** Thickness of Quaternary and Neogene Sediments in the Edmonton-Calgary Corridor (GIS data, ASCII grid format)

**DIG 2011-0003** Surficial Geology of the Thickwood Hills Area (NTS 84A/NE) (GIS data, polygon features)

**DIG 2011-0004** Surficial Geology of the Thickwood Hills Area (NTS 84A/NE) (GIS data, line features)

**DIG 2011-0005** Surficial Geology of the Thickwood Hills Area (NTS 84A/NE) (GIS data, point features)

### Maps

**MAP 548** Thickness of Quaternary and Neogene Sediments in the Edmonton-Calgary Corridor NTS 82O, 82P, 83A, 83B, 83G and 83H. Scale 1:500 000

**MAP 549** Bedrock Topography of the Edmonton-Calgary Corridor NTS 82O, 82P, 83A, 83B, 83G and 83H Scale 1:500 000

**MAP 555** Surficial Geology of the Thickwood Hills Area (NTS 84A/NE)

### Open File Reports

**OFR 2010-12** Bedrock Topography and Sediment Thickness Mapping in the Edmonton-Calgary Corridor, Central Alberta: An Overview of Protocols and Methodologies

## Meet Our Staff

### Corey Froese, AGS Manager

How long have you been with AGS?
Almost six years (I started in August 2005)

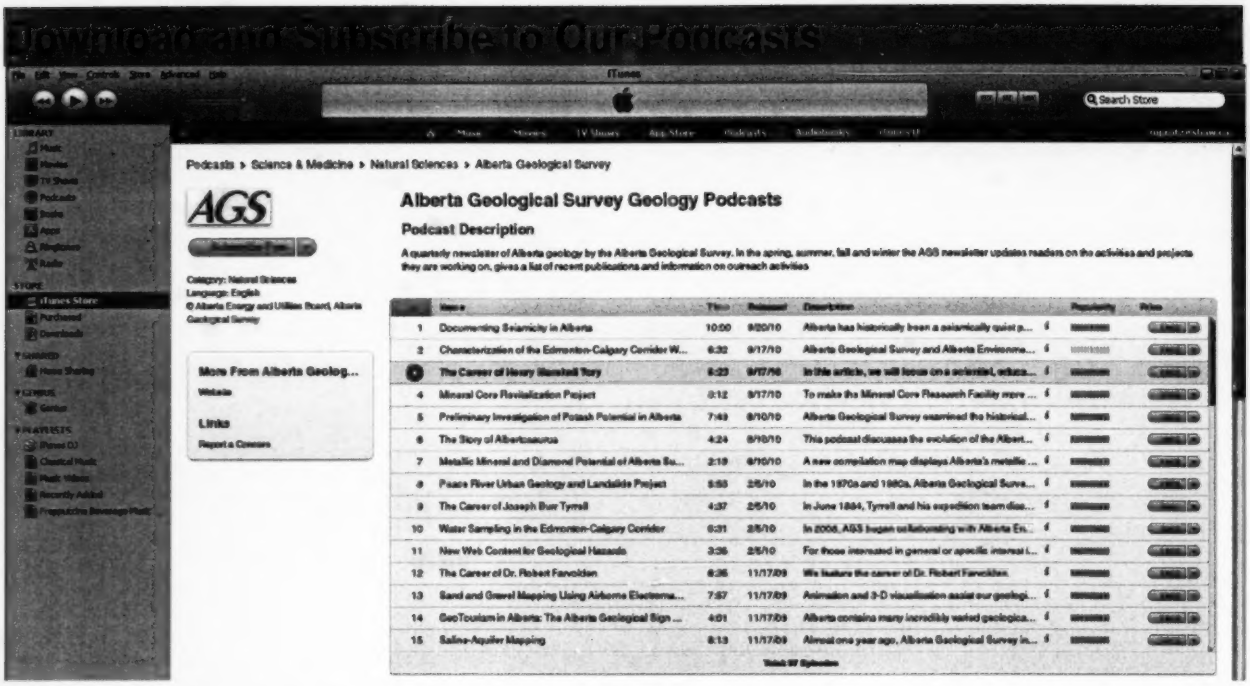
What is your field of expertise?
I am a geological engineer, and therefore, my area of practice in general is engineering geology. My specific area of expertise is in the area of landslide characterization and warning.

What is your professional claim to fame?
I have been very fortunate to have been working on the monitoring and warning system on Turtle Mountain since 2003. As this site has garnered significant interest in the international landslide community and the Canadian popular media, I am fairly well known for my work on this site. For visitors to the Frank Slide Interpretive Centre, I'm "that guy in the video."

Where is the most interesting place on Earth that you have worked?
Definitely on the fjords of western Norway. I sit on the expert panel for the Norwegian Rock Slope Warning Centre and the Norwegian government brings me over annually to review the work that it is doing, including some neat field visits.

What is your favorite geological place/feature in Alberta?
I love spending time on the Peace River in northwestern Alberta, where I've spent a good portion of my career to this point looking at landslides and understanding the complex glacial geology of the region.

Why did you pick this career?
In first year engineering at the University of British Columbia, someone from each of the engineering disciplines came in and gave us an overview. When I found out that geological engineering would allow me to apply engineering principles with my love of the outdoors, I was hooked. ❖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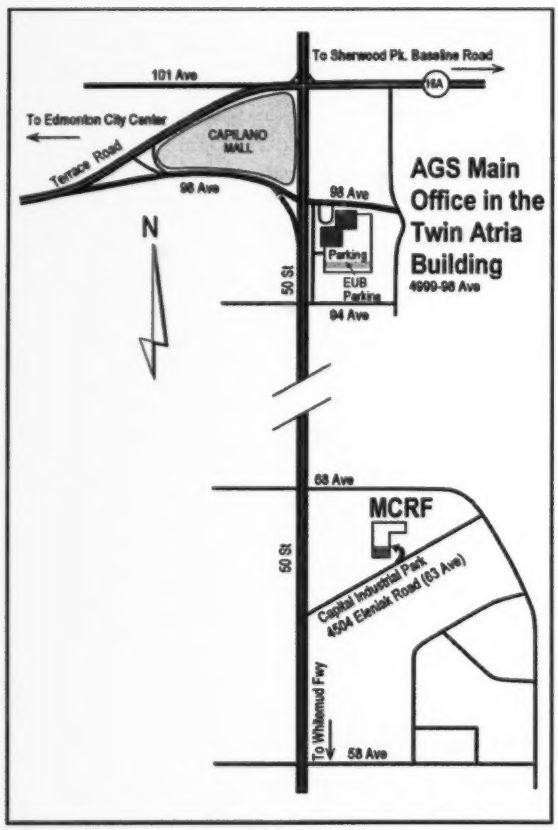


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